



Cooling Water Intake System (CWIS) Periodic Compliance

1.0 INTRODUCTION

The ENSCO 8502 has been contracted to work in the Gulf of Mexico for Nexen Petroleum. As such, rules and regulations as required by local and federal agencies are to be observed. One such entity that will regulate our operations in this region is the U.S. Environmental Protection Agency (EPA).

The EPA has advised *"For facilities utilizing devices other than surface intake screens, the facility shall monitor intake velocity at the point of entry through the intake device or through a comparable method such as pump curve calculations. The operator shall monitor either head loss or velocity during initial facility startup, and thereafter, at a frequency of no less than once per quarter."*

EnSCO has elected to utilize pump curve calculation and head pressure to calculate the relevant intake velocities (refer to report **CWIS Study Results** dated 8 June 2011).

2.0 DOCUMENT OBJECTIVE

The purpose of this document is outline the method that was used to determine velocities and to show the reader how to gather the required data and reference the relative flow velocity across the intake screens.

These measurements should be performed more frequently than once per quarter and are intended to demonstrate that the system remains substantially in the condition as designed between actual examinations during UWILD (Underwater Inspection in Lieu of Dry-Docking).

3.0 Pump curves

The rig's cooling pumps have been supplied with accurate pump curves. These curves are supplied with Flow on the X axis and Head on the Y axis. We have re-scaled these curves so that for the purposes of determining velocity at the intake screen for the EPA, the X axis is Velocity and the Y axis is Pressure at the pump.

The velocity at the intake screen can be read directly off the supplied charts for the Thruster cooling pump curve attached to this report. Adjustments must be made if any of the parameters below are not as indicated.



In the example of the Thruster cooling pump we determined that we could input the pressure parameter into a polynomial curve so that the EPA desired velocity in fps is output based on the required inputs from rig personnel. We were also able to include in the formulas corrections for vessel DRAFT and for FREQUENCY.

4.0 Parameters affecting Velocity

a. Vessel Draft

The pump curves will be affected by draft as this affects head. The curves are slightly different as Allweiler provided a curve for the Thruster cooling pumps using 64.3 lbs/ft³ seawater and 64.4 lbs/ft³ seawater for the Engine / SWS cooling pumps.

If the vessel is at a different draft than 55 ft, the pressure must be corrected before reading the velocity from the Curve. The pressure adjustment is determined as follows:

ECPA = Engine (& Salt Water) Cooling Pump Pressure adjustment (psi)

TPA = Thruster Cooling Pump Pressure adjustment (psi)

AD = Actual Draft (feet)

$$TPA = (55 - AD) \times 0.4465$$

$$ECPA = (55 - AD) \times 0.4472$$

Example: If the actual thruster cooling pump pressure is read as 60 psi, but the draft is 60 ft, then the pressure must be adjusted before reading velocity off the curve.

$$TPA = (55 - 60) \times 0.4465 = -2.2 \text{ psi}$$

Therefore the velocity should be determined using 60 psi – 2.2 psi = **~ 58 psi**.

- b. **Pump speed** affects velocity. This relationship is directly proportional. The affected pumps on the ENSCO 8502 are all rated and wound to operate at 1750 rpm. The pump speed must be 1750 rpm provided that the frequency on the 480 bus is 60.0 Hz. The velocity must be adjusted if the Electrical frequency is not as expected.

At the time the pressure readings are taken the frequency must also be recorded and if necessary the velocity read from the pump curves adjusted by the factor determined in this formula.

Where:

SF = Speed Factor

HzA = Actual Frequency (Hz)

$$SF = \text{HzA}/60$$



Example: If for example the velocity was read from the chart as 0.44 fps, but the actual frequency was found to be 61.5 cycles.

$$SF = 61.5/60 = 1.025$$

Therefore the actual velocity would be $0.44 \text{ fps} \times 1.025 = \underline{0.45 \text{ fps}}$.

5.0 Discussion of Assumptions and Known Data.

The Engine Cooling System is always partly below sea level (pump and sea chest) and partly above sea level Claval in to overboard flume. From KFELS drawing P205 & P206, we know that the Salt Water and Engine cooling pumps are 6ft 8-1/2" above Base line. Therefore at a 55 ft draft there is an existing head on the pumps of 48.29 feet with no flow. The Allweiler Salt Water and Engine cooling pump curves are based on a seawater density of 64.4 lbs/ft³, which is a gradient of 0.4472 psi/ft.

The Thruster Cooling Pumps complete system is normally below sea level. From KFELS drawing P209, we know that the Thruster cooling pumps are 16ft 2-1/4" above Base line. Therefore at a 55 ft draft there is an existing head on the pumps of 38.81 feet with no flow. The Thruster cooling pump discharge is also below sea level at elevation 27ft 3-1/2" as shown in drawing P213. This discharge ties into the Engine & SW flume system as shown in drawing P251. The Allweiler Thruster pump curves are based on a seawater density of 64.3 lbs/ft³, which is a gradient of 0.4465 psi/ft.

6.0 Derivation of polynomials

In the Graphing functions of Microsoft Excel© one is able to fit a curve with an approximate polynomial and test that polynomial with actual inputs to a known graph. We found slight errors in this Microsoft Excel© function but were able to converge on the best fit polynomial with minimal effort.

For the Thruster cooling pump curve on page 6 we derived the following formula;

$$V = -0.0009 \times (P)^2 + .0785 (P) - 1.052 \text{ (with both pumps running)}$$

To correct for Draft and Frequency, the formula entered into the protected spreadsheet is $V = SF1 \times ((-0.0009 \times (P + TPA)^2 + .0785 (P + TPA) - 1.052))$.

The spreadsheet is further adjusted to recognize if both pumps or only one pump is running as this will change the velocity by a factor of 2. All cells in the spreadsheet are protected except for those requiring data and instructions are given on the first tab of the worksheet.



ENSCO 8502

CWIS Periodic Compliance

Deepwater Technical Support

Prepared by: MSF

Revised: 19 July, 2011

Page 4 of 4

The polynomial best fit to the Engine cooling pumps and Thruster Cooling pumps, including corrections, was;

$$V = SF1 \times ((-0.00000014 \times (P + ECPA)^3) + (0.00011 \times (P + ECPA)^2 - .0233 (P + TPA) + 1.6306)).$$

ALLWEILER**Charact. curves
NISM 65-250/01**

Charact. curves acc. DIN EN ISO 9906 Class 2
Admissible minimum capacity 10 % * Q(opt) at continuous operation
Remarks:

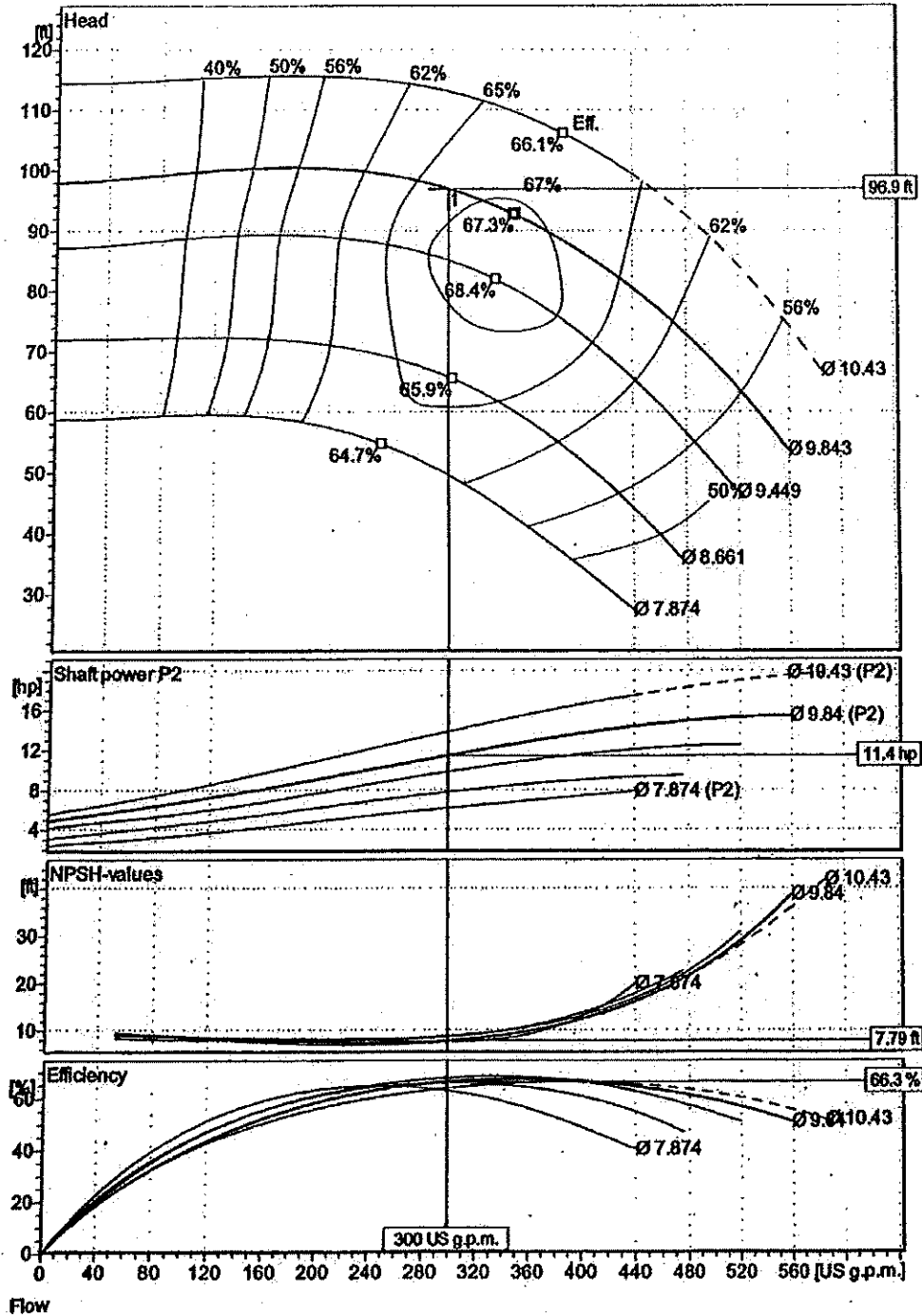
Quotation / Offer No. ---

Project ID
- General Service PumpsItem 17: Thruster Cooling Pump
Pos.No:

Created by

Date
2006-05-29Power data referred to: Sea water [100%]; 30°C; 64.3lb/ft³; 0.793mm/s

Speed — 1750 rpm

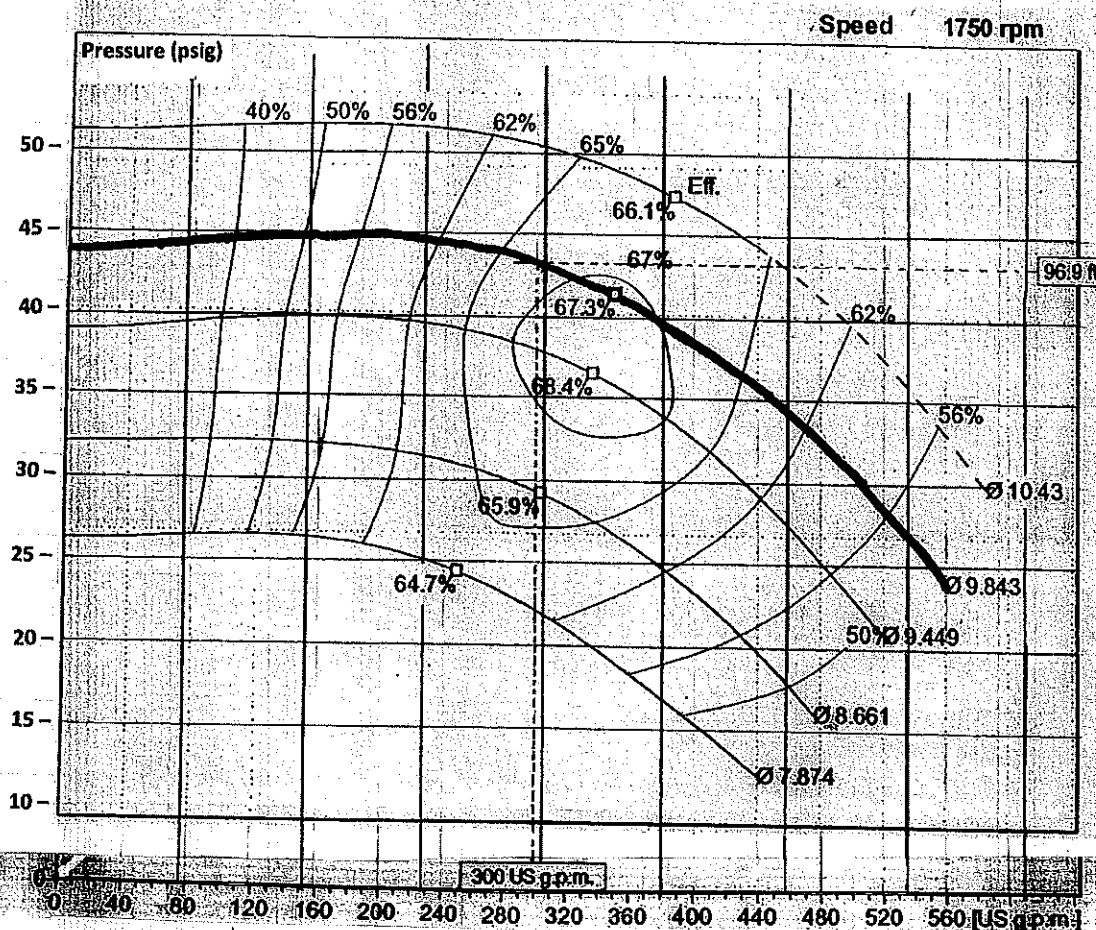


Thruster Cooling Pump Curve

(used to determine Intake Screen Velocity by reading discharge pressure at the pump)

(No correction for Draft required for operating drafts down to 28 feet)

(ONLY the Curve for $\phi 9.843$ IMPELLER APPLIES)



Intake Screen Velocity with One Thruster Pump Running (Feet per Second)

0.05 0.10 0.15 0.20 0.25 0.30 0.35 0.40

Intake Screen Velocity with Two Thruster Pumps Running (Feet per Second)

0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80